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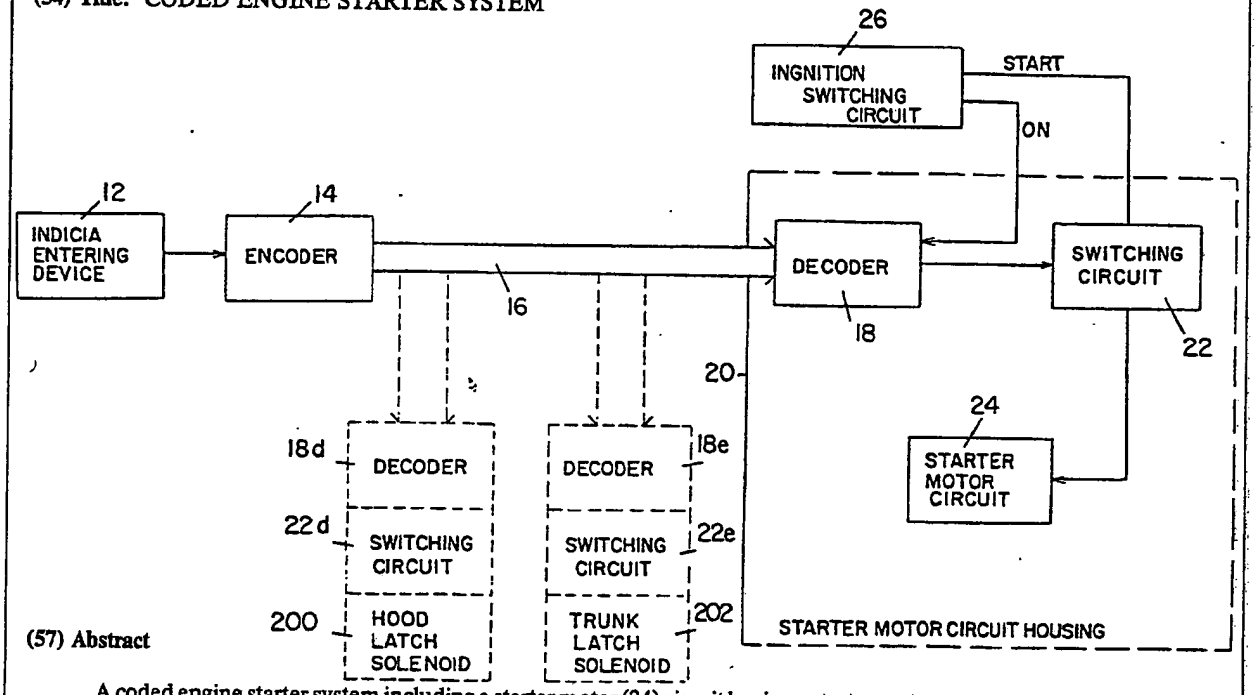

(57) Abstract

A coded engine starter system including a starter motor (24) circuit having a starter motor; a starter motor circuit housing (20) for housing the starter motor circuit; means, external to the starter motor circuit housing, for entering identifying indicia into the system (21); means, external to the starter motor circuit housing and responsive to the means for entering, for encoding entered indicia (19); means disposed in the starter motor circuit housing for recognizing a predetermined code from the means for encoding (18); switching means (22), disposed in the starter motor circuit housing and responsive to recogniti n of a predetermined code by the means for recognizing, for enabling the starter motor circuit to receive power to operate the starter motor; and means for transmitting code from the means for encoding to the means for recognizing (16).

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CODED ENGINE STARTER SYSTEM

BACKGROUND OF THE INVENTION

This invention relates to a coded engine starter system, and more particularly to such a system in which the coding and code recognition intelligence is distributed, with the code recognition device in the starter motor circuit housing and the code generating mechanism in a remote entry device.

Auto theft is a major problem and there is a wide variety of devices for attempting to discourage and impede it. Mechanical anti-theft devices include steering wheel locks, gas line blocks, and foot brake locks. However, once identified, such devices can either be bypassed or forcefully defeated by a clever thief. Electrical anti-theft devices include in addition to burglar alarms, hidden "kill" switches which are inserted in various places,e.g., the coil circuit, key switch circuit, battery circuit, solenoid or starter motor circuit, to interrupt the normal operation of those circuits unless the switch is actuated. However, as soon as a thief identifies the presence of such a switch, its usefulness is at an end. For even if he cannot locate the switch, it is a simple matter to locate the particular component being controlled by the switch and simply "jump" the terminals under switch control or provide battery voltage directly to the proper terminal of the controlled device. More sophisticated approaches have similar vulnerability. For example, one presently available unit uses a keypad or similar means for entering identifying indicia, e.g., one or more numbers or letters whose output is connected to a code recognition circuit that operates a "kill" switch in the coil circuit when the one correct code has been entered on the keypad. However, once the thief identifies the system he can either open the keypad to see which of the keys are actually wired for the coded output or, even more simply, go to the switch and strap it out by bringing the necessary voltage directly to the coil.

SUMMARY OF THE INVENTION

It is therefore an object of this invention to provide an improved, simple, inexpensive and extremely effective anti-theft coded engine starter system.

It is a further object of this invention to provide such a system which disables the starter motor circuit so that the engine cannot be rotated for starting.

It is a further object of this invention to provide such a system which is compatible for use with existing starter motor circuits.

It is a further object of this invention to provide such a system which cannot be thwarted using additional hardware equipment or jumper lines.

It is a further object of this invention to provide such a system which is not vulnerable to conventional thieving techniques such as electrical "jumping" or "strapping" or mechanical bypassing or force.

It is a further object of this invention to provide such a system which necessitates disassembly, modification, and reassembly of the starter motor circuit or replacement of it with another in order to overcome the disability imposed by this system.

It is a further object of this invention to provide such a system which automatically rejects improper code entry and requires resetting before re-use to thwart operation by children or intoxicated persons.

It is a further object of this invention to provide such a system which uses complex coding techniques to encode the coded information to reduce the possibility that the proper code can be duplicated to operate the starter motor circuit.

The invention results from the realization that a truly effective anti-theft device can be made by locating within the starter motor circuit housing all the vulnerable parts of the starter motor circuit, a switching circuit

for operating the starter motor circuit and a recognition device which only enables actuation of the switching circuit and thus the starter motor circuit upon receipt of the proper code from an external or remote code generator, because then there is no way to operate the starter motor circuit to rotate the engine without either disassembling, modifying and reassembling, or removing and replacing the entire apparatus.

The invention features a coded engine starter system having a starter motor circuit which includes a starter motor. There is a starter motor circuit housing which houses the starter motor circuit. Means external to the starter motor circuit housing are provided for entering identifying indicia into the system. Also external to the starter motor circuit housing are means responsive to the means for entering indicia, for coding entered indiciaThere are means disposed in the starter motor circuit housing for recognizing a predetermined code from the encoder. Switching means, also disposed in the starter motor circuit housing, is responsive to the recognition of a predetermined code by the means for recognizing to enable the starter motor circuit to receive power for operating the starter motor. Means are provided for transmitting the code from the means for encoding to the means for recognizing.

In specific applications, the starter motor circuit may include simply a starter motor, or a starter motor and a solenoid, for closing contacts in the starter motor circuit and moving the drive pinion of the starter motor. Alternatively, the starter motor circuit means may include a movable pole shoe mechanism, in addition to the starter motor, for closing contacts in the starter motor circuit and moving the drive pinion of the starter motor.

The system typically further includes an ignition switching circuit which in the "start" position applies

power through the switching circuit to the starter motor circuit. In the "on" position, the ignition switching circuit applies power to the encoder. The ignition switching circuit 26 may include relays to switch heavy current. The starter motor circuit housing may include simply the starter motor housing, which may contain just the starter motor or the starter motor and the remainder of the starter motor circuit, e.g., pole shoe mechanism or solenoid. Alternatively, the starter motor circuit housing may include a starter motor housing and an additional housing for containing the solenoid or pole shoe mechanism or other device which forms a part of the starter motor circuit. The two housings may be either integral or seprate, but if separate, they are fixed together.

The means for enteringt identifying indicia may include a keyboard, and the switching means may include an SCR. The means for propogating the encoded indicia may include one or more electrical conductors even if said conductors are also used to supply DC operating power to the devices concerned.

The means for encoding may include a coding circuit for producing a code representative of entered indicia, and a modulation circuit for modulating a carrier signal with the code representative of entered indicia. The means for recognizing may include a demodulation circuit responsive to the carrier signal for distinguishing the code representative of entered indicia from the carrier signal, and means for detecting the predetermined code. The means for recognizing may also include gate means for delivering a signal to operate the switching means upon recognition of the predetermined code, and timer means for disabling the gate means if the predetermined code is not completely transmitted with a preselected period of time. Additionally the means for recognizing may include error circuit means for disabling the gate means if any part of the predetermined code is in error. In conjunction with either or both

both of these disabling circuits, there is provided a reset means for re-enabling the gate means after it has been disabled. The modulating and demodulating circuits may be frequency modulated, and the means for encoding may include an encryption degvice for increasing the complexity of code with an encryption decoder device located in the means for recognizing to detect the more complex code.

DISCLOSURE OF PREFERRED EMBODIMENTS

Other objects, features and advantages will occur from the following description of a preferred embodiment and the accompanying drawings, in which:

FIG. 1 is a block diagram of a coded engine starter system according to this invention;

FIG. 2 is a more detailed schematic diagram of one implementation of the decoder, switching circuit and starter motor circuit of FIG. 1;

FIG. 3 is a detailed sectional diagram showing the physical location of the decoder, switching circuit, and starter motor circuit of FIG. 2 in the starter motor circuit housing according to this invention;

FIG. 4 is a more detailed schematic diagram of another implementation of the decoder, switching circuit and starter motor circuit of FIG. 1;

FIG. 5 is a detailed sectional diagram showing the physical location of the decoder, switching circuit, and starter motor circuit of FIG. 4 in the starter motor circuit housing according to this invention;

FIG. 6 is a detailed schematic diagram of yet another implementation of the decoder, switching circuit, and starter motor circuit of FIG. 1;

FIG. 7 is a side sectional view of an additional housing for a solenoid according to this invention;

FIG. 8 is a block diagram illustrating in greater detail one construction of the encoder and decoder of FIG. 1;

FIG. 9 is a block diagram showing an implementation of the means for transmitting of FIGS. 1 and 8;

FIG. 10 is a more detailed block diagram of another implementation of the encoder of FIG. 1; and

FIG. 11 is a block diagram of another implementation of the decoder of FIG. 1.

The invention may be accomplished with a coded engine starter system according to this invention, which employs a starter motor circuit including a starter motor. The starter motor circuit may include simply the starter motor or it may include a solenoid, a pole shoe mechanism, or some other device for controlling with a lighter current the heavier current to the starter motor and/or operating the drive pinion of the starter motor.

There is a starter motor circuit housing for housing the starter motor circuit. This housing may be the housing of the starter motor itself, in those cases where the starter motor circuit includes simply the starter motor, and even in those cases where the starter motor circuit includes more than the starter motor, the additional circuitry and parts may be included in the same housing as the starter motor. Often the additional parts, such as the pole shoe mechanism or solenoid mechanism, are included in separate housings. Those housings may be either integral with or at least fixed to the starter motor housing

There are some means for entering identifying indicia into the system. This may be a keyboard for entering one or more numbers or letters, a credit card reading device, a device for sensing voice pattern characteristics, a device for reading fingerprint patterns, a device for recognizing particular handwriting signature patterns, or any other similar device. The identifying indicia, whatever it may be, is submitted to some means for qualification which provides a code indicating a valid operator representation.

The coding may take a simple form: ten switches and wires for electrically representing ten decimal keys 0 - 9 of a keyboard. The coding may also include converting

the ten decimal lines to four-bit binary code. The electrical signals may be in analog or digital form. In addition, the encoding may also include more complex techniques for transmitting the code by, for example, mixing it with other information or signals, e.g., modulation of a carrier with the code. This can reduce to one the number of conductors used to transmit the code to the means for recognizing in the starter motor circuit housing. Further, the input could be subjected to an encryption device whereby, for example, the raw input or a four-bit binary code derived from the input is encrypted in a twelve-bit binary code. Such a tech- can make the code with which it is to operate by various means whichmake it difficult to tamper with it, i.e., disassemble or remove it, for example welding, one-way screws, or screws or bolts which require peculiar tools or wrenches to move them.

There is shown in FIG. 1 a coded engine starter system 10 according to this invention, which includes indicia entering device 12 whose output is encoded by encoder 14 and then delivered by some transmitting means 16 to decoder 14 and then delivered by some transmitting means 16 to decoder 18 located within starter motor circuit housing 20. Detection of a predetermined code, representing predetermined indicia, by decoder 18 enables switching circuit 22 to close starter motor circuit 24. Then when ignition switching circuit 26 is moved to the "start" position, there is applied B+ through the closed switching circuit 22 to operate starter motor circuit 24. Power is provided to decoder 18 by ignitition switch 26 in the "on" position.

In one construction, the starter motor circuit 24, FIG. 2, includes a starter motor 30 and solenoid 32, all housed along with decoder 18 in starter motor circuit housing 20. Switching circuit 22 is shown including a silicon control rectifier, hereinafter SCR, 34. When decoder 18 recognizes the proper predetermined code, it energizes gate 36 of SCR 34 and enables the necessary voltage, for

example battery voltage B+, to be conducted from anode 38 through its cathode 40, to the pull-in coil 42 of solenoid 32, if the ignition switch is in the "start" position. Initially, pull-in coil 42 moves solenoid plunger 43 in the direction of arrow 46 causing contact 44 to close the circuit from terminal 48 connected to B+ to terminal 50. As solenoid plunger 43 moves, it also moves the drive pinion of motor 30 toward engagement with teeth on the flywheel of the engine to be started. When contact is finally made between contact 44 and contacts 48 and 50, the main solenoid (holding coil) coil 52 is energized to securely hold plunger 43 in that position and simultaneously the full battery current is applied to motor 30, which drives the engine flywheel through the now fully engaged drive pinion on motor 30.

In FIG. 2, the only wires accessible outside of the housing 20 are line 54, which is a portion of the transmitting means 16 which brings the coded signal to decoder 18, the anode 38 of SCR 34, and one or more lines directly or indirectly connected to B+. Clearly, whether or not B+ is present on these lines or at anode 38, the system cannot operate unless the proper code on line 54 is first recognized by decoder 18. Note that even though terminals 48 and 50 have their portions 48' and 50' (see also FIG.3) located external to housing 20, the only result of "jumping" these external terminals 48' and 50' is that motor 30 will spin. However, its drive pinion will not be engaged with the flywheel and the engine cannot be rotated. Note #45 surge suppressor.

This is more apparent in FIG. 3, where motor 30 is shown having a shaft 60 on which shift fork 62 moves drive pinion 64 with overrunning clutch 66 against the force of spring 68 when solenoid plunger 43 moves in the direction of arrow 46 driven by pull-in coil 42.

Housing 20 includes both a housing 70 which includes motor 30, and a housing 72 which includes solenoid

32; housings 70 and 72 are integrally combined to form essentially a single housing unit.

Alternatively, as shown in FIG. 4, where like parts have been given like numbers accompanied by a lower case a, starter motor circuit 24a includes starter motor 30a having a rotor 80 with suitable energizing connections, and four field windings 82, 84, 86 and 88. Also included in starter motor circuit 24a is a holding coil 90 and switching means 92 including a pair of contacts 94 and 96. When decoder 18a has received the proper code on line 54a, it provides a signal to gate 36a which enables power to be applied through SCR 34a when the ignition switch is in the "start" position. Initially contacts 94 and 96 are closed so that field coil 82 is connected directly from battery B+ to ground. The powerful current therefore flowing through field coil 82 enables it to draw down a pole shoe and with it a crank that moves the drive pinion toward engagement with the teeth on the flywheel, and opens contacts 94 and 96. At that time, the pole shoe is in its new position, and holding coil 90 is able to keep it in this position. Simultaneously, with the ground lifted from field coil 82, all the coils 82, 84, 86 and 88 are being energized and rotor 80 of motor 30a through its drive pinion rotates the flywheel of the engine.

The physical relationship of the parts is shown in FIG. 5, where the pole shoe 100, located in the coil 103 which contains field winding 82 and holding winding 90, is attached to crank 62a. Initially6, when field coil 82 begins to move pole shoe 100 downwardly as indicated by arrow 102, crank 62a also moves overrunning clutch 66a and drive pinion 64a outwardly on shaft 60a, at the same time moving to open switching circuit 92 by separating contacts 94 and 96.

In simple starter motor circuit 24b, FIG. 6, which includes essentially only motor 30b (for example a Bendix system in which the drive pinion is positioned by centri-

fugal force), motor 30b is energized directly upon the setting of the ignition switch to the "start" position when SCR 34b has been closed bymeans of the signal on line 36 from decoder 18b, upon the proper predetermined code being recognized on line 54b.

In arrangements such as shown in FIG. 2, SCR 34 may be a relatively low-power device, for it only serves to provide current to the initial pull-in coil 42, and in fact the anode 38 may be connected directly to the ignition switch. However, in arrangements such as shown in FIGS. 4 and 6, where SCR's 34a and 34b respectively must pass full motor current, SCR's of somewhat heavier ratings are required and anode 38 may in fact, as is typically the case, be connected to the battery B+ supply through a power relay in the ignition switching circuit 26.

In cases where a portion of the starter motor circuit is not properly contained within the starter motor circuit housing, or where there is unsufficient room in the existing starter motor housing for the decoder, suitable housings can be constructed. For example, solenoid 32c, FIG. 7, is provided with its own housing 110 that will be fixed to the starter motor housing and which contains in it a space 112 to hold the decoder 18c. Solenoid 32c is assembled into housing 110 by means of some type of security fasteners so that the starter motor circuit, decoder, and switching circuit are all safely housed where they cannot be tampered with.

Indicia entering device 12 may include a keyboard 120, FIG. 8, and encoder 14 may include a coder circuit 122 for providing a digitally coded signal, FM modulator 124, an FM carrier source 126, which provides a 100 KHz signal, and a timer circuit 146 for locking out the carrier after a maximum human default interval.

This 100 KHz carrier signal modulated by the digital code is delivered by the means for transmitting 16 to decoder 18, wherein phase lock loop circuit 128 re-

sponds to the 100 KHz carrier signal and demodulates it to provide the digitally coded signal to a serial-to-parallel converter 130. Signals other than 100 KHz are not recognized by phase lock loop circuit 128, and no demodulation and detection of the digital code is effected. This is an added safety feature so that the thief must not only duplicate the code but must duplicate the FM modulation at the particular carrier frequency in order to operate decoder 18.

To service a four-digit code, serial-to-parallel converter 130 is shown as having four positions 132, 134, 136 and 138, whose contents are provided to comparator 140. If the contents of converter 130 match the contents of reference circuit 142, i.e., the predetermined code, then a signal is provided to gate 144 and is delivered to the gate 36 of SCR 34 in swtiching circuit 22.

When the first decoded signal arrives, it is stored at position 132 of converter 130. As the second code digit arrives, the first shifts to position 134 and the second occupies position 132. This continues until all four digits are loaded in converter 130. If any one of the numbers in sections 132, 134, 136 and 138 is not the proper number, comparator 140 provides a signal through circuit 150 to OR gate 148, which disables gate 144.

Once gat4e 144 is disabled, a proper signal can no longer be passed from comparator 140 to SCR 34. This is, subsequent to an erroneous entry or an entry that took too long to complete, even the predetermined code will not result in a signal to SCR 34 unless gate 144 is reset, for example by turning off the system with the ignition key switch and then turning it back on again.

The means for transmitting 16 may be implemented by any of various known transmission techniques. For example, it may simply include an FM transmitter 160, FIG. 9, with an antenna 162 for broadcasting the signal to a receiver and another antenna 164 which provides an input

to FM receiver 166.

Encoder 14 may include more elaborate coding techniques, for example following coder circuit 122 there may be a comparison made between reference in circuit 170, FIG. 10, which contains the predetermined code. If then comparator 172 recognizes that an incoming signal has the proper predetermined code, it provides a signal to gate 174 to enable encryption device 176 to provide a complex encryption of that predetermined code. For example, a twelve or twenty-digit binary code may be provided by encryption device 176. Encryption device 176 may be a read only memory (ROM) constructed to repeatedly provide a particular code. The output of encryption device 176 may then be submitted to FM modulator 124 as before, and after demodulation in decoder 18 it is fed to an encryption recognition circuit 178, FIG. 11, which may be implemented by a ROM set in the same way as the ROM used in encryption circuit 176, the output of whichmay be fed to gate 144 as previously.

Although thus far the invention has been illustrated with respect only to starter motor circuits, this is not a necessary limitation of the invention. For example as shown in FIG. 1, similar arrangements of decoder 18d, switching circuit 22d and a hood latch solenoid 200, or decoder 18e, switching circuit 22e and trunk latch solenoid 202 may also be used.

It is evident that those skilled in the art, once given the benefit of the foregoing disclosure, may now make numerous other uses and modifications of, and departures from the specific embodiments described herein without departing from the inventive concepts. Consequently, the invention is to be construed as embracing each and every novel feature and novel combination of features present in, or possessed by, the apparatus and techniques herein disclosed and limited solelyby the spirit and scope of the appended claims.

WHAT IS CLAIMED IS:

1. A coded engine starter system comprising:

a starter motor circuit including a starter motor;

a starter motor circuit housing for housing said starter motor circuit;

means, external to said starter motor circuit housing, for entering identifying indicia into said system;

means external to said starter motor circuit housing and responsive to said means for entering, for encoding entered indicia;

means, disposed in said starter motor circuit housing, for recognizing a predetermined code from said means for encoding;

switching means, disposed in said starter motor circuit housing and responsive to recognition of a predetermined code by said means for recognizing, for enabling said starter motor circuit to receive power to operate said starter motor; and

means for transmitting code from said means for encoding to said means for recognizing.

2. The system of claim 1 including an ignition switching circuit for applying power to said switching circuit.

3. The system of claim 1 in which said starter motor circuit includes a solenoid for closing contacts in said starter motor circuit and moving the drive pinion of said starter motor.

4. The system of claim 1 in which said starter motor circuit includes a movable pole shoe mechanism for closing contacts in said starter motor circuit and moving the drive pinion of said starter motor.

5. The system of claim 1 in which said starter motor circuit housing includes the starter motor housing.

6. The system of claim 1 in which said starter motor circuit includes a solenoid for closing contacts in said starter motor circuit and moving the drive pinion of

said starter motor and in which said starter motor circuit housing contains said starter motor and said solenoid.

7. The system of claim 6 in which said starter motor circuit housing includes a starter motor housing and a solenoid housing fixed together.

8. The system of claim 1 in which said starter motor circuit includes a movable pole shoe mechanism for closing contacts in said starter motor circuit and moving the drive pinion of said starter motor, in which said starter motor circuit housing contains said starter motor and said pole shoe mechanism.

9. The system of claim 8 in which said starter motor circuit housing includes a starter motor housing and a pole shoe mechanism housing fixed together.

10. The system of claim 1 in which said means for entering includes a keyboard.

11. The system of claim 1 in which said switching means includes an SCR.

12. The system of claim 1 in which said means for transmitting includes conductor means interconnected between said means for encoding and said means for recognizing.

13. The system of claim 12 in which said conductor means includes one wire.

14. The system of claim 1 in which said means for transmitting includes ans RF transmitter and an RF receiver.

15. The system of claim 1 in which said means for encoding includes a coder circuit for producing a code representative of entered indicia and a modulation circuit for modulating a carrier signal with the code representative of entered indicia.

16. The system of claim 15 in which said means for recognizing includes a demodulation circuit responsive to the carrier signal to distinguish the code representative of entered indicia from the carrier signal and means for

detecting said predetermined code.

17. The system of claim 15 in which said means for generating a carrier signal upon recognition of said predetermined code and timer means for disabling said means if said predetermined code is not completely entered within a preselected period of time.

18. The system of claim 17 in which said means for recognizing includes error circuit means for disabling said gate means if the received code is not said predetermined code.

19. The system of claim 17 in which said system includes reset means for re-enabling said gate means after it has been disabled.

20. The system of claim 18 in which said system includes reset means for re-enabling said gate means after it has been disabled.

21. The system of claim 16 in which said modulation and demodulation circuits are frequency modulating and demodulating.

22. The system of claim 1 in which said means for encoding includes an encryption device for increasing the complexity of the code.

23. The system of claim 22 in which said means for recognizing includes an encryption decoder device.

24. The system of claim 1 further including a second means for recognizing a second predetermined code, second switching means, and a hood latch solenoid for actuating said hood latch when said second predetermined code is recognized.

25. The system of claim 1 further including a third means for recognizing a third predetermined code, third switching means, and a trunk latch solenoid for actuating said trung when said third predetermined code is recognized.

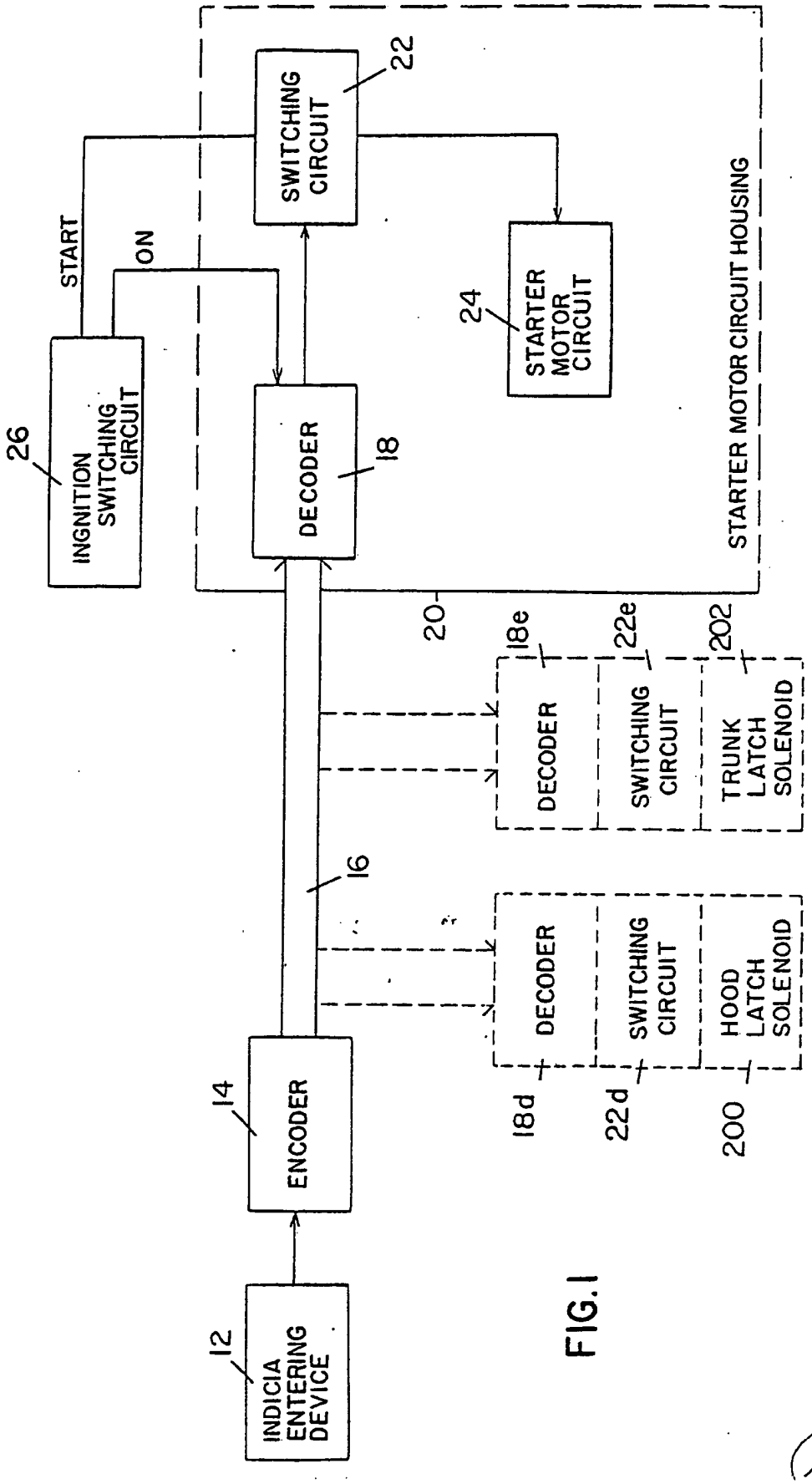

FIG.1

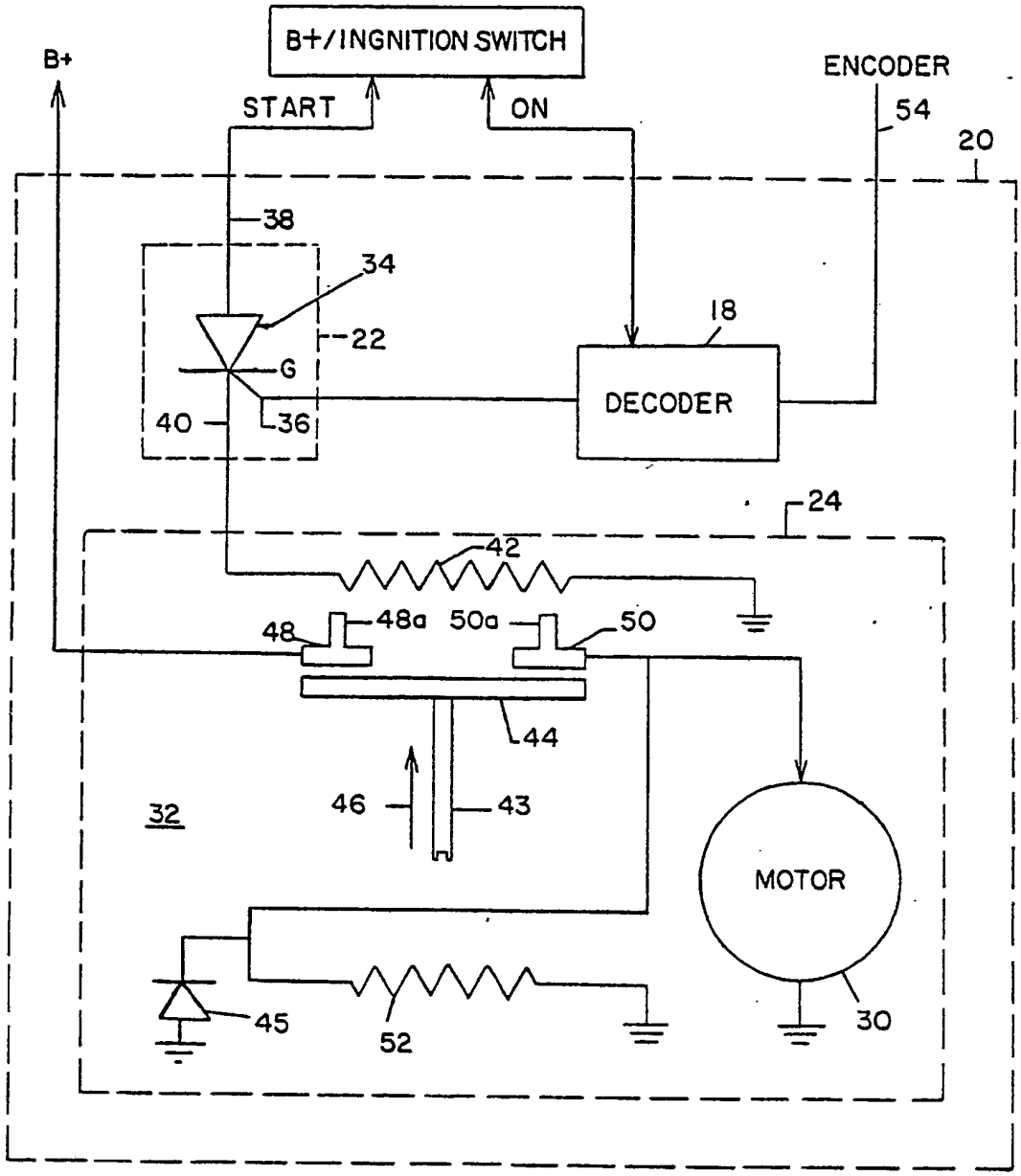

FIG. 2

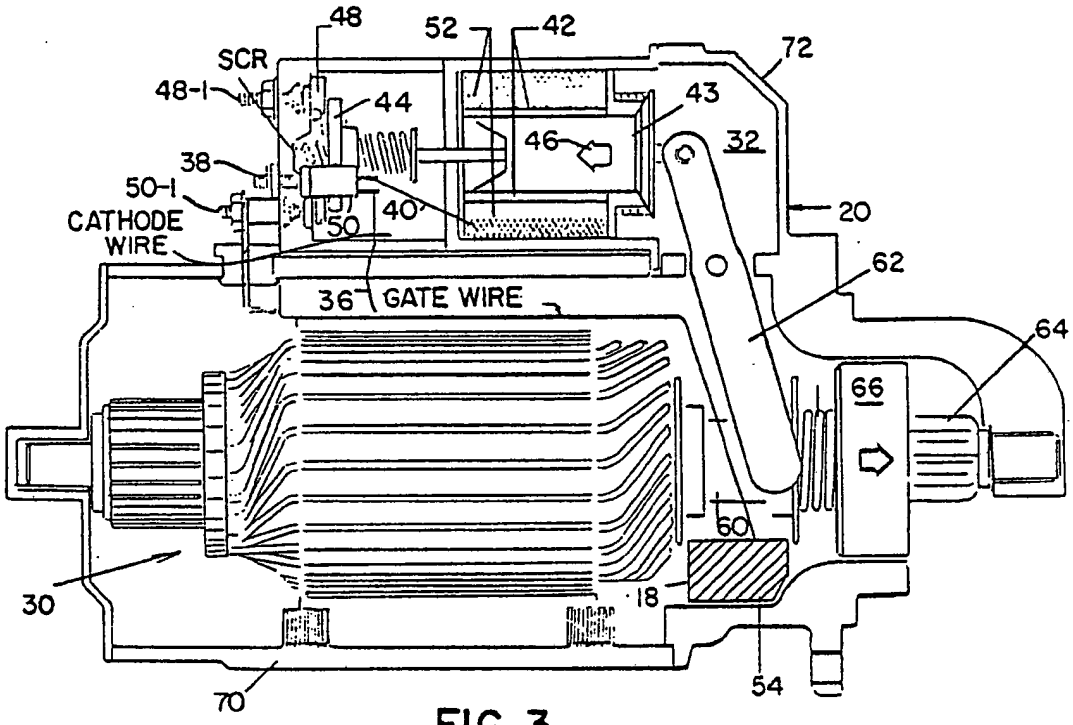

FIG. 3

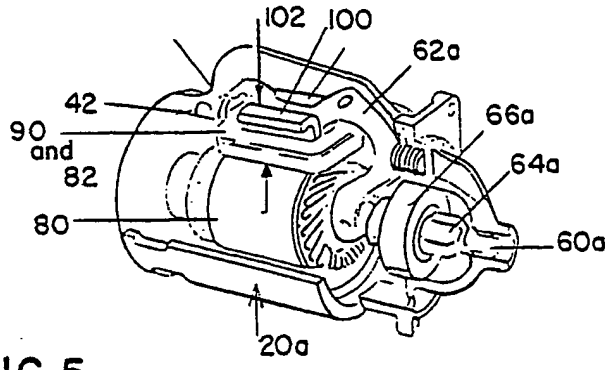

FIG. 5

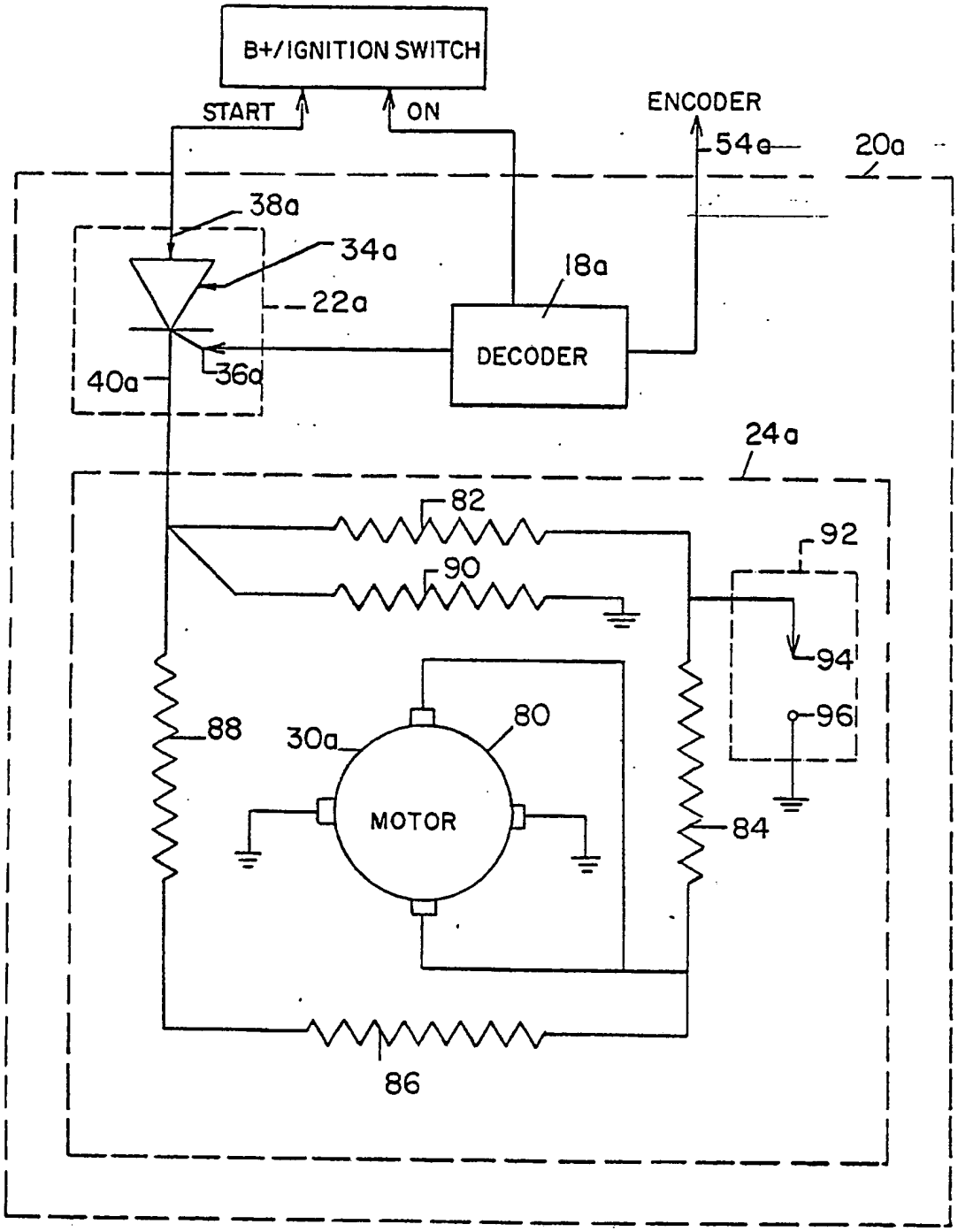

FIG. 4

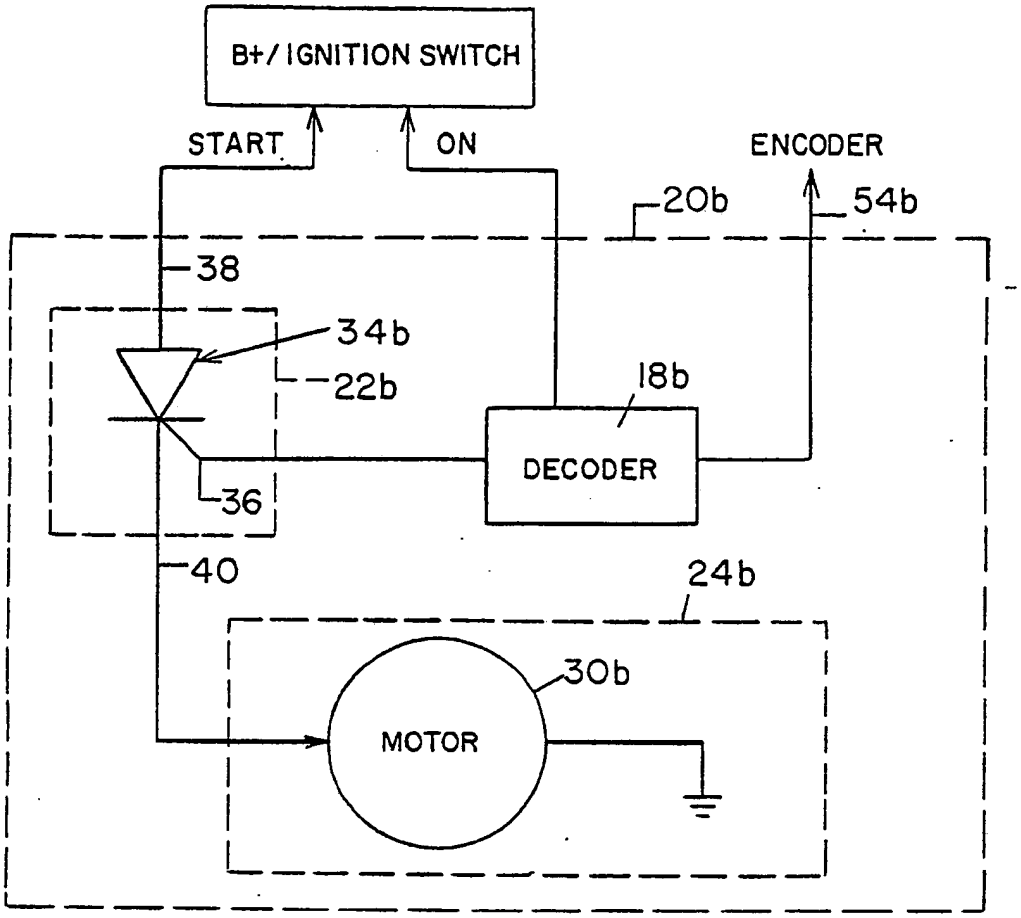

FIG. 6

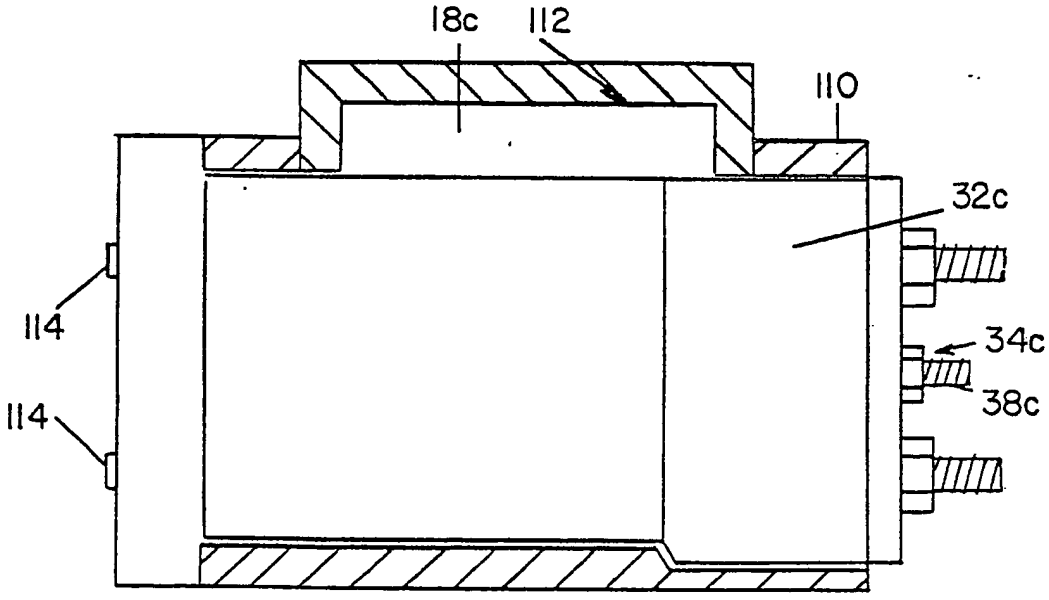

FIG. 7

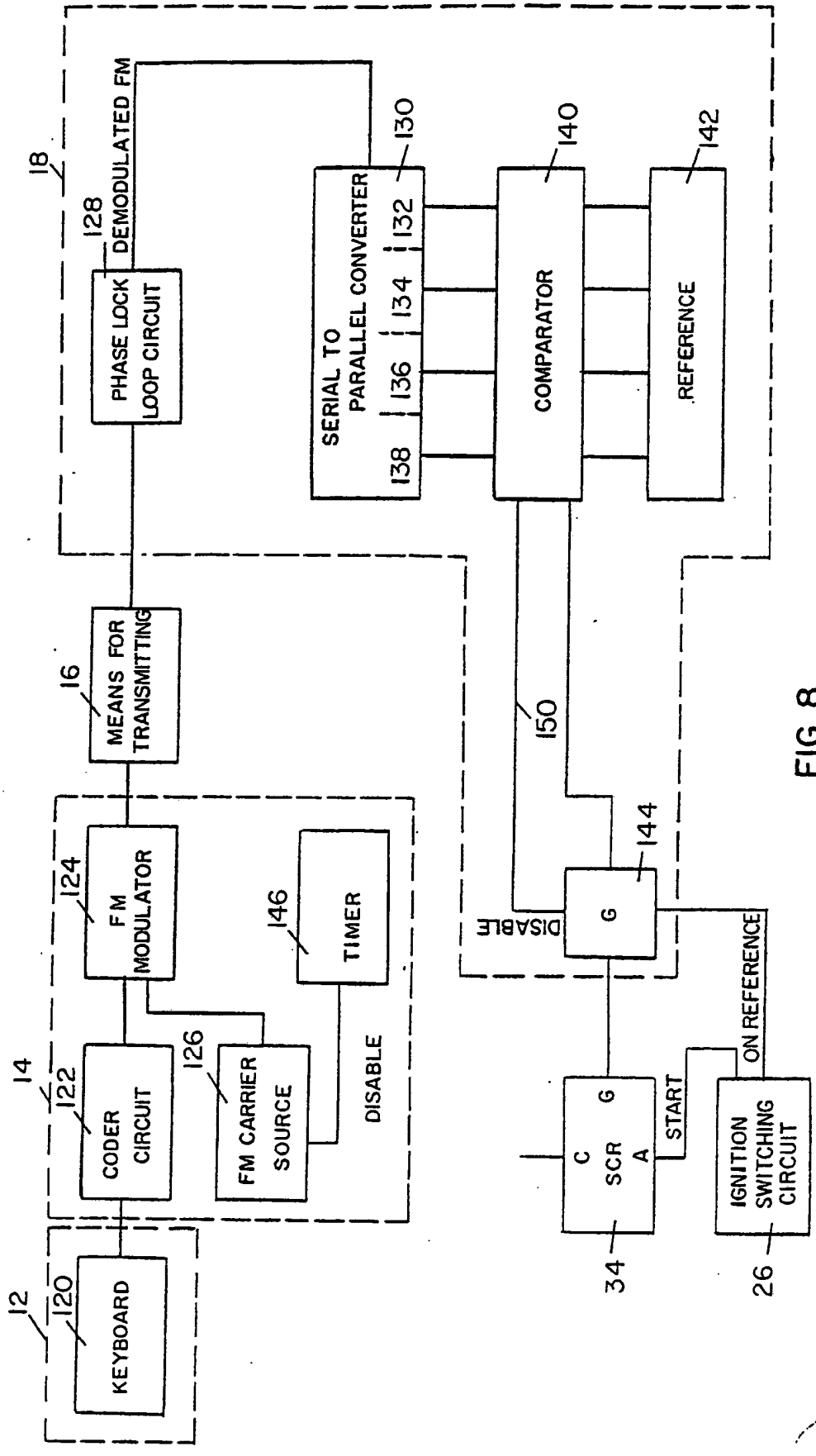

FIG. 8

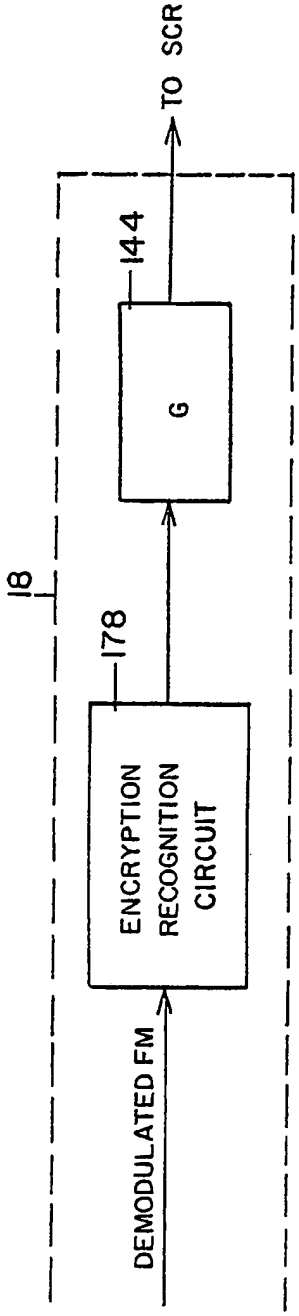

FIG. 11

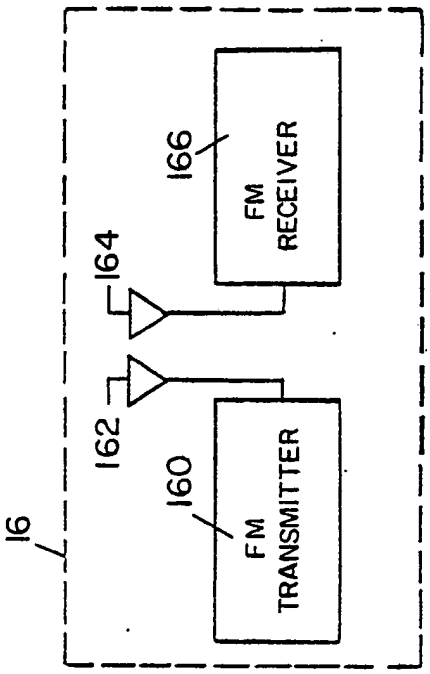

FIG. 9

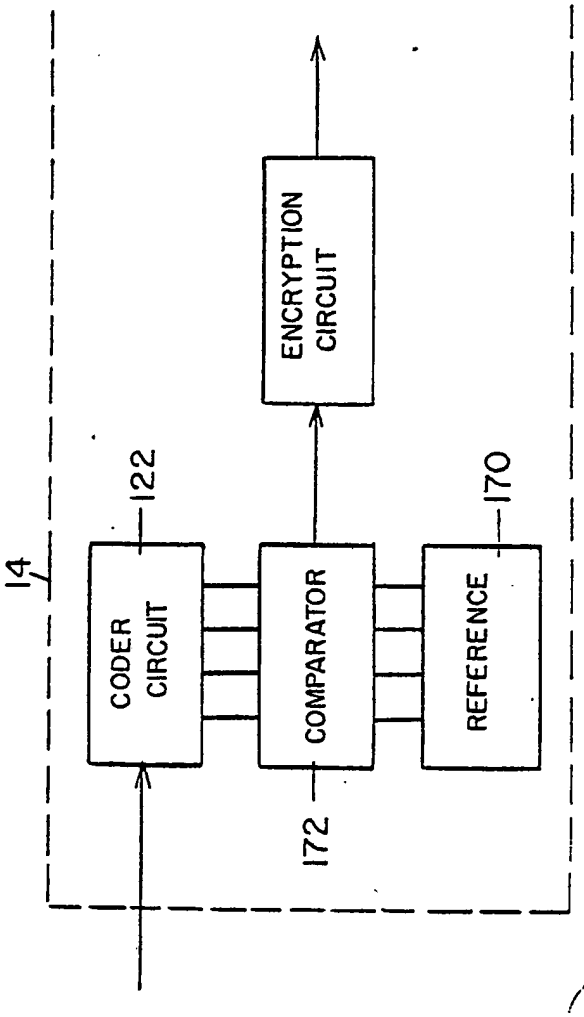

FIG. 10

INTERNATIONAL SEARCH REPORT

International Application No PCT/US81/00533

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) 3

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC - B60R 25/04
US - 361/172

II. FIELDS SEARCHED

Minimum Documentation Searched 4	
Classification System	Classification Symbols
US	361/172,173 307/10AT

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched 5

III. DOCUMENTS CONSIDERED TO BE RELEVANT 14

Category *	Citation of Document, 16 with indication, where appropriate, of the relevant passages 17	Relevant to Claim No. 18
X,P	US, A, 4222034, Published 9 September 1980	1-25
X,P	US, A, 4209709, Published 24 June 1980	1-25
X	US, A, 4192400, Published 11 March 1980	1-25
X	US, A, 4157478, Published 5 June 1979	24-25
A	US, A, 4186710, Published 5 Febuary 1980	
A,P	US,A, 4240516, Published 23 December 1980	

* Special categories of cited documents: 15

"A" document defining the general state of the art

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"L" document cited for special reason other than those referred to in the other categories

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but on or after the priority date claimed

"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention

"X" document of particular relevance

IV. CERTIFICATION

Date of the Actual Completion of the International Search 2	Date of Mailing of this International Search Report 2
4 August 1981	03 SEP 1981
International Searching Authority 1	Signature of Authorized Officer 20
US	L. C. Schroeder

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